

**Near Room Temperature SiO₂ Deposition
Using Cyclic O₂ Plasma Treatment**

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In active matrix liquid crystal display (AMLCD) application, low-temperature processing is desirable to reduce the manufacturing cost by utilizing low cost glass substrate. Plastic materials will be another candidates of substrate for TFT-LCD devices and it demands lower processing temperature. The concept proposed in this paper is to do O₂ plasma intermediate treatment periodically between cyclic oxide depositions using TEOS/O₂. Oxide deposition time was regulated to deposit 6nm thickness oxide per one cycle. The TEOS residual gas after oxide deposition was purged out of the chamber for 1 min and at the same time, the film was treated by O₂/He plasma gases at 40watt for 1 min.

From the refractive index (Fig. 1), we can evaluate the film density, ρ , using the Lorenz-Lorenz relationship.¹ The film density of cyclically deposited oxide at 50°C is 2.138 g/cm³ and it is slightly smaller than film density of thermally grown oxide, 2.25g/cm³. However, the film density of normally deposited oxide at 50°C is 1.923 g/cm³, which shows the film is porous. Fig. 2 shows the leakage current density at the 1MV/cm electric field and the leakage current density of cyclically deposited oxide is smaller than normally deposited oxide. This smaller leakage current of SiO₂ film is in general due to the tightly bonded Si-O networks with less residual hydroxide or alkoxide. We have done SIMS analysis to find out impurity contents. Cyclically deposited oxide has less carbon and hydrogen atoms and more oxygen. O₂ plasma treatment after each 6nm oxide deposition enhanced the dissociation of carbon or hydrogen impurities in the oxide film. Increase of impurity in the oxide film makes the C-V curve distorted from the ideal shape. Fig. 3 shows the C-V plot of oxide film deposited at 50°C. In case of cyclic CVD oxide, the shape of C-V curve was improved. Using Terman method,² we calculated the interface trap density (D_{it}) at mid-gap. The D_{it} of cyclically deposited oxide was $1.38 \times 10^{11}/\text{eVcm}^2$ and normally deposited oxide was $5.27 \times 10^{12}/\text{eVcm}^2$.

In conclusion, we have obtained high quality SiO₂ film at near room temperature using cyclic deposition with intermediate O₂ plasma treatment. Film density of silicon oxide deposited at 50°C increased and carbon or hydrogen impurity in oxide film was decreased. Leakage current density of cyclically deposited oxide film was decreased and also the interface trap density at mid-gap was decreased.

References

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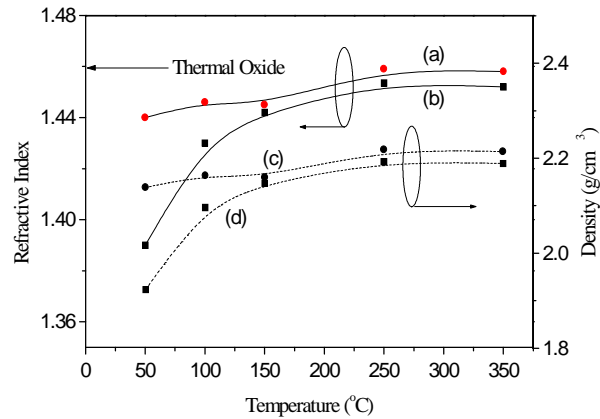


Fig. 1 Refractive index and film density with different temperature. Refractive index of (a) cyclic CVD oxide and (b) normally deposited silicon oxide. Film density of (c) cyclic CVD oxide and (d) normally deposited oxide.

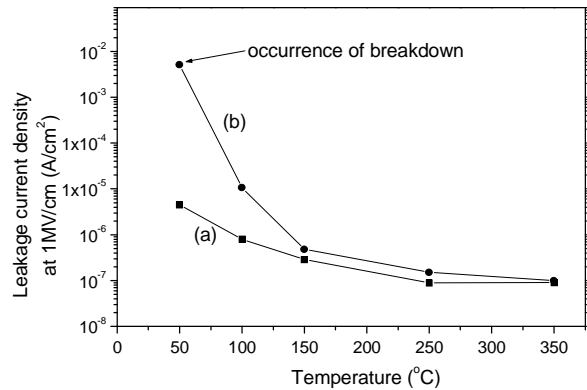


Fig. 2 Leakage current density at 1MV/cm with different deposition temperature. (a) cyclic CVD oxide (b) normally deposited silicon oxide.

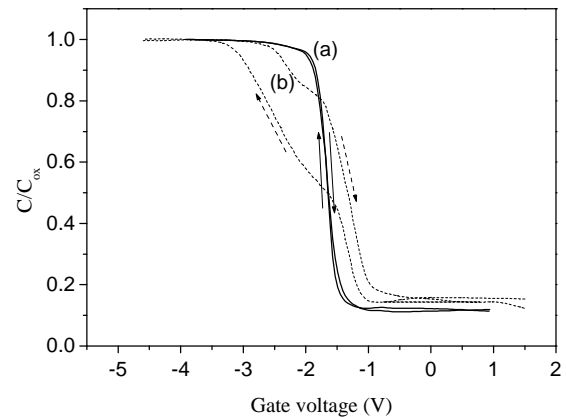


Fig. 3 C-V curves of the silicon oxide films deposited with different deposition methods. (a) oxide film deposited with cyclic deposition method and (b) normal deposition method. Deposition Temperature and pressure: 50°C, 1torr, respectively